

## THE RIBEIRA FOLDED BELT

YOCITERU HASUI, CELSO DAL RÉ CARNEIRO e  
ARMANDO MÁRCIO COIMBRA

**ABSTRACT** A tectonic differentiation along the coastal region of South America between Bahia State, Brazil, and Uruguay is observed on a longitudinal as well as on a transversal direction.

Longitudinally, a *Northern Segment* is distinguished from a *Southern Segment*. The first, with a relatively simple megastructure, presents the Paraíba do Sul Folded Belt (Transamazonian Cycle, 1800-2200 m.y.) later remobilized during the Brazilian Cycle (450-650 m.y.), and the infrastructure of the Ribeira Folded Belt of Brazilian age.

The Southern Segment is structurally more complex and is in itself a zoned entity, presenting from NW to SE the *Apiaí Folded System*, the *Joinville Median Massif*, the *Tijucas Folded System*, the *Pelotas Median Massif* and the *Eastern Uruguay Folded System*.

A characteristic of the Folded Systems are ecinitic rocks from the greenschist and amphibolite facies, migmatized in some regions. The Joinville Central Massif presents mainly gneissic-migmatitic sequences, partly related to the Brazilian Cycle, while others are of earlier consolidation (Transamazonian Cycle or even older). The Pelotas Central Massif is constituted by migmatitic units of Brazilian age, corresponding to a zone of early consolidation.

The two longitudinal segments are separated by a wide zone of transcurrent faulting — the *São Paulo Transcurrence Zone* — with a dextral horizontal displacement of about 300 km. The Transcurrence Zone may have influenced the present setting by a vertical component. The São Roque Group is restricted to this Zone and cannot be considered a prolongation of the Açungui Group. The authors consider it rather a separate entity, originally constituting another Folded System to the NW of the Açungui Group.

**RESUMO** O volume de dados disponíveis sobre as faixas dobradas ao longo da região costeira entre a Bahia e o Uruguai permite já distinguir uma diferenciação tectônica longitudinal e transversal.

Longitudinalmente, identifica-se o *Segmento Setentrional*, de estruturação simples, dada pela Faixa Dobrada Paraíba do Sul (Ciclo Transamazônico, 1800-2200 m.a.), remobilizada no Ciclo Brasileiro (450-650 m.a.), e pela infraestrutura da Faixa Dobrada Ribeira, formada neste último ciclo.

O *Segmento Meridional* é mais complexo, podendo-se diferenciar transversalmente, de NW para SE, o *Sistema Dobrado Apiaí*, o *Maciço Mediano Joinville*, o *Sistema Dobrado Tijucas*, o *Maciço Mediano Pelotas*, o *Sistema Dobrado Uruguai Oriental*.

Os sistemas de dobramento compõem-se de ecinitos de fácies xisto verde a anfibolito, por vezes migmatizados. O Maciço Central Joinville é formado sobretudo por seqüências gnáissico-migmatíticas, em boa parte da idade Brasileira e de consolidação precoce. Núcleos mais antigos ocorrem neste maciço, como a Formação Encantadas no Rio Grande do Sul, de idade Transamazônica; o Complexo Básico-Ultrabásico de Barra Velha, com idades arqueanas, incluído no Complexo Tabela em Santa Catarina; no Paraná, granulitos e rochas básico-ultrabásicas transamazônicas ou mesmo mais antigas aparecem entre os migmatitos do Complexo Cristalino; em São Paulo, alguns núcleos migmatíticos e granulíticos pré-brasileiros também foram identificados. O Maciço Central Pelotas é formado por unidades migmatíticas do Ciclo Brasileiro e corresponde a uma zona de consolidação precoce.

Os dois segmentos se conectam através da *Zona de Transcorrência São Paulo*, que não só provocou um deslocamento horizontal dextral da ordem de 300 km, mas também deve ter influído na diferenciação longitudinal, graças a uma componente vertical do rejeito.

O chamado *Grupo São Roque* restringe-se à área da Zona de Transcorrência São Paulo e não pode ser considerado simples prolongamento do Grupo Açungui. Os autores admitem que o Grupo São Roque constituiria originalmente parte de outro sistema de dobramento situado a NW do Sis-

Instituto de Geociências, Universidade de São Paulo, C.P. 20899, São Paulo, Brasil

tema Apiaí e paralelo a ele. Dessa forma, os ectinitos do Grupo Açungui são sincrônicos àqueles do Grupo São Roque, da mesma forma que aos do Sistema Tijucas (Grupos Brusque, Porongos e Lavalaja) e do Sistema Uruguai Oriental (Grupo Rocha).

**INTRODUCTION** Our knowledge of the basement rocks of the South American Platform as exposed from Bahia, Brazil, to Uruguay, were greatly enhanced from 1965 on by geological, tectonic and geochronological studies. Regional synthesis were presented by Ferrando and Fernandes (1971) on Uruguay, Picada (1971) on Rio Grande do Sul, Brito Neves and Albuquerque (1973) on Santa Catarina, Fuck *et al.* (1971) on Paraná, Melcher *et al.* (1973) on Southern São Paulo State and Hasui and Sadowski (in press) on Southeastern São Paulo State. A interpretative essay by Coutinho (1971) deals with Southern Brazil. Ferreira (1972) outlined the accepted interpretation on the Ribeira Folded Belt, of Brazilian age (450-650 m.y.). Almeida *et al.* (1973) described the Ribeira Belt and its relations to the older Paraíba do Sul Belt (Transamazonic Cycle, 1800-2200 m.y.), treating the Brazilian-Uruguayan Coast.

In 1973, C. D. R. Carneiro, A. M. Coimbra and A. Thomaz Filho discerned the existence of a "structural high" separating the Açungui Group from the Brusque-Porongos-Lavalaja Groups. They explained this new approach at the 28th. Brazilian Geological Congress, held at Porto Alegre, RS, in 1974 (Carneiro *et al.*, 1974).

The purpose of this paper is to present, from an analysis of previous work, a scheme of the longitudinal and transversal zoning within the Ribeira Belt, along the coastal region between Bahia State, Brazil, and Uruguay.

**LONGITUDINAL DIFFERENTIATION** A clear-cut longitudinal differentiation into two segments is observed within the exposed South American Platform (Fig. 1); both segments are connected at the São Paulo-Rio de Janeiro latitudes.

The *Northern Segment* extends from Rio de Janeiro through Espírito Santo, eastern Minas Gerais and Southern Bahia. Cordani (1973) recognized the existence of two lithologic units, with elongation and structural trends more or less parallel to the coastal line. The western lithologic unit comprises mainly gneissic-migmatitic rocks, with syn- and post-tectonic granitic bodies (see Barbosa *et al.*, 1966, for petrographic details). Barbosa and coworkers correlated it to the Serra dos Órgãos Series for which ages and additional informations are given by Delhal *et al.* (1969) and Cordani *et al.* (1973). This western unit represents the infrastructure of a Folded Belt (the so-called Ribeira Belt, Almeida *et al.*, 1973) metamorphosed and migmatized during the Brazilian Cycle (450-650 m.y.). Its western limit is not very well known.

The eastern lithologic unit is mainly constituted by kinzigitic gneisses and some granulitic areas. In general it is more highly metamorphosed than the former unit; it may be correlated to the Paraíba do Sul Series, formed during the Transamazonic Cycle and remobilized during the Brazilian Cycle (Cordani, 1973).

Both lithologic units are cut by the NW-trending Itapebi Fault at the latitude of the Jequitinhonha and Pardo Rivers. Thus, the Northern Segment is placed into contact with the Jequié Granulitic Complex (age 2700 m.y., Guriense Cycle; see Cordani, 1973). Cordani also describes a structural deflection, by which the Northern Segment acquires a NW structural trend from Southern Bahia to NW-Bahia and sets apart the São Francisco Craton from the Salvador Craton. To the South of the Itapebi Fault, structures are aligned SSW down to Rio de Janeiro State, where a structural deflection to about S45W occurs.

In short, the coastal units to the south of the Itapebi Fault were either formed during the Brazilian Cycle or are of Transamazonic age with later remobilization during the former.

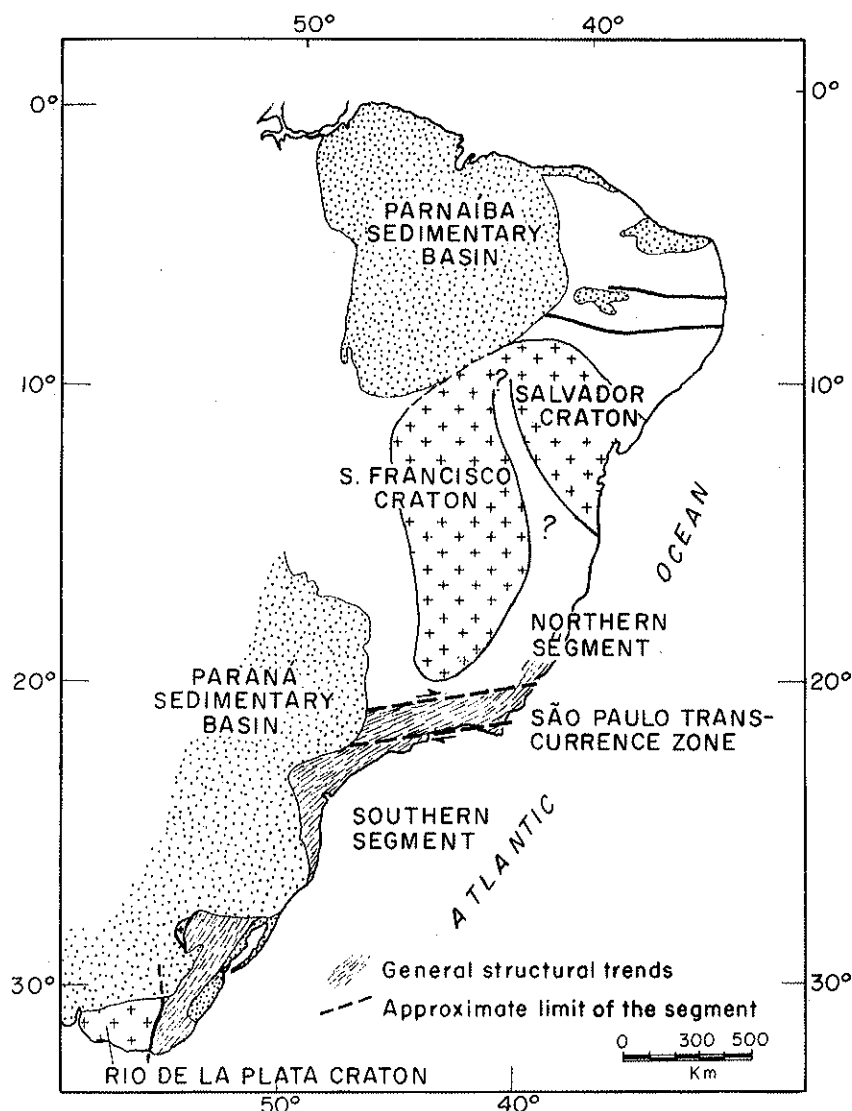


Figure 1 – The basement of South American Platform in the coastal region

In the lower Pardo River, covering an area of 600 km<sup>2</sup> over the Jequié Complex, there are metasediments known as the Rio Pardo Group (Pedreira *et al.*, 1969), probably preserved thanks to a local tectonic pattern; they have been related to the Brazilian Cycle (Cordani, 1973).

The *Southern Segment* is situated between the Ribeira de Iguape River valley and Uruguay. Its structural trend is NNE, with a deflection in Paraná and Southern São Paulo States to N45E. The segment is not continuously exposed, because it is in part covered by the palaeozoic-mesozoic stratigraphic units of the Paraná Basin (Fig. 2). One can observe the existence of small and scattered molassic deposits and andesitic-rhyolitic lava flows formed during the paraplatformal stage of the Brazilian Cycle; they constitute the Guaratubinha, Castro, Itajaí, Bom Jardim and Camaquã Groups, and the Camarinha, Iapó, Maricá, Sierra de Animas, Sierra de Rios and Piedras de Afilar Formations.

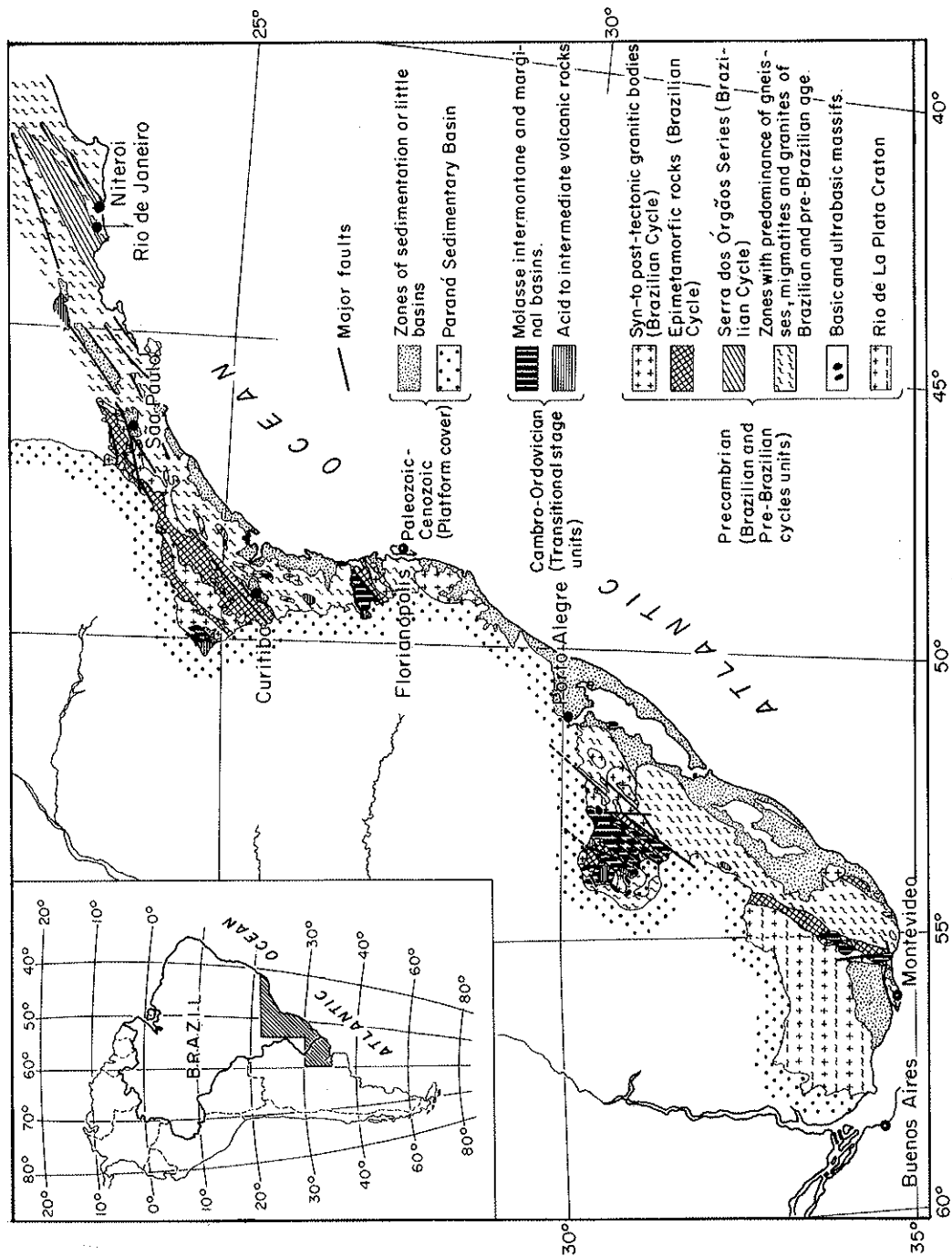


Figure 2 — Geologic-geotectonic sketch of the coastal region from Rio de Janeiro to Montevideo.

The Southern Segment is composed of ecinitic sequences and migmatitic complexes, both intruded by syn- and post-tectonic granitic bodies. The ecinitic sequences are named Açungui Group at Paraná and southern São Paulo State, Brusque Group at Santa Catarina, Porongos Group at Rio Grande do Sul and Lavalleja Group at Uruguay, all of them related to the Brazilian Cycle. The migmatitic complexes are regarded for the most part as been formed during the Brazilian, but there certainly are portions from an older cycle and rejuvenated during Brazilian events.

In brief, the Southern Segment was formed during the Brazilian Cycle and some older regions suffered remobilization and rejuvenation.

In Uruguay, to the west of the Lavalleja Group, there is a geotectonic unit named Rio de La Plata Craton (Almeida *et al.*, 1973) whose structures trend E-W and seem to continue under the Chaco sediments down to Sierra Baja, Sierra Azul and Sierra Tandil (Buenos Aires Province, Argentina). The age of that unit is about 2000 m.y. (Ferrando and Fernandes, 1971). Amos *et al.* (1971) consider the La Tinta Group of Buenos Aires Province as a platform cover deposited during Brazilian times.

As showed, the Southern Segment is constituted by lithologies not formed at a so deep level as the Northern Segment. The basement is well exposed in the Northern Segment, but in the Southern one it crops out modestly and in determinated places, as we will describe later.

The described segments are connected to each other not directly but through a zone which is present in the eastern São Paulo and Rio de Janeiro States. Both segments approach that zone with N45E structural trends; in this zone a very complex structure is observed, partially analysed by Hasui and Sadowski (in press). We can say only in a very general way that the structural trends are deviated as far as N70-80E. Many transcurrent faults have been recognized, some extending over 165 km (Taxaquara, Caucaia, Jundiuvira, Itu, Cubatão, Freires, Pirai and other faults); these discontinuities separate blocks with variable shapes and dimensions. The faulting network is not yet completely mapped, but we can postulate the existence of a macrozone of transcurrent movements. Braun (1972) extended this macrozone as far as the Rio Grande do Sul territory and named it Paraíba do Sul Rupture Zone. The present authors are of the opinion that, rather than deviating to the south, the macrozone holds its direction and continues under the palaeozoic sediments of the Paraná Basin, there constituting the Parapanema "Structural High" recently defined by Fúlfaro (1974). We propose to name the macrozone *São Paulo Transcurrence Zone*.

The total movement of the São Paulo Transcurrence Zone was dextral and displaced the Northern and Southern Segments of the Ribeira Belt. The slip has not been determined since there are no accurate geological references; we can only estimate a minimum value of 300 km considering the Serra dos Órgãos Series as a correlate of the migmatites occurring in Parapanema Mountains (Embu Complex of Hasui, in press).

Hasui and Sadowski (in press) showed that the transcurrent movements began after the regional metamorphism and continued until the end of Brazilian Cycle with a minimum time interval of about 650 to 450 m.y..

In the eastern region of the São Paulo Transcurrence Zone we find lithologies of higher metamorphic grade; they are considered as belonging to the Paraíba do Sul Belt (Cordani, 1973), but at least partially they must have formed during the Brazilian Cycle and are thus related to the Ribeira Belt. The existence of a vertical slip in the transcurrent movements should explain the absence of epimetamorphic rocks in the Paraíba do Sul River valley region. If the western part of the São Paulo Transcurrence Zone, as well as the Northern Segment, were elevated by the movements, we can understand why we observe outcrops of meso- and catazonal rocks at the present-day erosion level. Strengthening this

view Hennies *et al.* (1967) observed friction lineations in the faulting zone of Taxaquara inclined to the west with variable angles as high as 20°.

Concluding, we can say that there is a longitudinal differentiation of the basement of the South American Platform in the coastal region. North from Rio de Janeiro State the general structure is relatively simple, with a mesometamorphic Brazilian Belt superimposed on a mesocatazonal substratum. The São Paulo Transcurrence Zone is an important boundary in the N-S differentiation and seems to have contributed to its development.

**TRANSVERSAL DIFFERENTIATION** The ectinitic and gneissic-migmatitic units of the Southern Segment and of the São Paulo Transcurrence Zone are shown in Fig. 2. Also shown are the chief granitic bodies and the molassic-volcanic sequences of the para-plattformal phase. Three ectinitic systems separated by two gneissic-migmatitic zones can be clearly recognized as indicated in Fig. 3.

From NW to SE, the *first ectinitic system* spreads along the Paraná and São Paulo States; it is cut by the São Paulo Transcurrence Zone on its northeastern extremity and covered

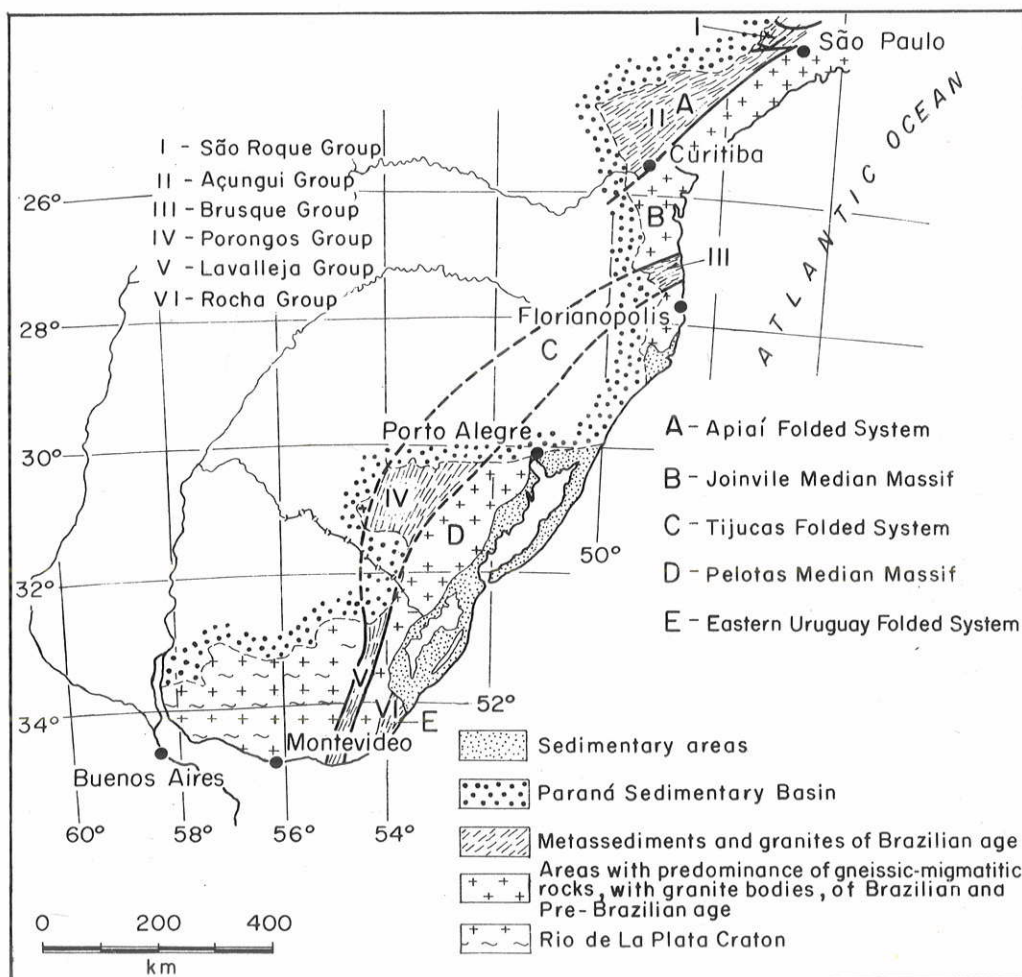


Figure 3 - Folded Systems and Median Massifs of the Ribeira Folded Belt

by the Parana Basin's sedimentary units at its southern side. It presents ectinitic rocks formed under conditions of greenschist and amphibolite facies, known stratigraphically as the Açungui Group. The contact of this system with the first gneissic-migmatitic zone occurs by faulting in Paraná State; in southern São Paulo State, Melcher *et al.* (1973) recognized a transitional relation.

The *first gneissic-migmatitic zone* is named Crystalline Complex in Paraná, and Marini *et al.* (1967) described it as a pre-Brazilian unit. However, Cordani (1974) and Girardi *et al.* (1974) have obtained Brazilian ages for migmatites, and Transamazonian and older ages for granulites and basic-ultrabasic rocks. Besides, there are older nuclei exposed in the middle of the migmatites. The Crystalline Complex continues in Santa Catarina State as the Taboleiro Complex (northern part). K-Ar data for pyroxenites, amphibolites and migmatites from the Barra Velha region spread between 700 and 3400 m.y. (Minioli, 1972), indicating the existence of an older nucleus, rejuvenated during successive events. In the western region of the Sul-Riograndense Shield, Cordani *et al.* (1974) have obtained 2260 m.y. (Rb/Sr reference isochron) and Issler *et al.* (1972) reported a K-Ar age of 2000 m.y. for the Mata Grande gabbro. In southern São Paulo, Cordani and Bittencourt (1967) also obtained an age of 1600 m.y. (K/Ar method), which they explain as related to a pre-Brazilian nucleus in an anticlinal core. A similar case has been observed by Sadowski (1974a) in the southeastern São Paulo State, at the Cubatão Ridge region; the Brazilian and pre-Brazilian zones have been distinguished by structural criteria. Sadowski (1974b) also suggests that the Itatins Block, of granulitic composition, could be another ancient nucleus.

The shape, dimensions, limits and spatial distribution of the pre-Brazilian nuclei have not yet been completely investigated. They are found in the Brazilian gneissic-migmatitic zone, at the São Paulo region, in the Crystalline Complex, in the Taboleiro Complex and in the western Sul-Riograndense Shield. They seem to correspond partially to an extension of the Paraíba do Sul Belt, and crop out as segments of the Brazilian basement. At the southern edge, the first gneissic-migmatitic zone is cut by faults, setting it apart from the second ectinitic system.

The *second ectinitic system* is represented by the Brusque Group in Santa Catarina, the Porongos Group in Rio Grande do Sul and the Lavallega Group in Uruguay. All these stratigraphic units are constituted by ectinitic rocks of the greenschist to amphibolite facies. Its southeastern edge is in contact with the *second gneissic-migmatitic zone*, which has local names as Taboleiro Complex (southern part) in Santa Catarina State and Dom Feliciano "Craton" in Rio Grande do Sul State. Faults separating the two units have been recognized at Rio Grande do Sul (Canguçu Dorsal Zone) and at Santa Catarina. Equivalent faults have not as yet been observed in Uruguay, but structural discordances seen in the map of Bossi (1966) — very clearly stated in some regions to the north and southeast of Minas where the structures of the Lavallega Group and of the migmatites are transversal to each other — may well be the result of faulting. A transitional contact seems also to exist in the region north of Treinta y Tres (Bossi, 1966, p. 411) and there the structures are parallel. Cordani *et al.* (1974) obtained Brazilian ages for the Dom Feliciano "Craton". The data of Hart and of Halpern, Umpierre and Linares (*in* Ferrando and Fernandes, 1971) indicate also Brazilian ages for the gneissic-migmatitic zone of eastern Uruguay.

The *third ectinitic system* crops out in eastern Uruguay and is covered by the Cenozoic sediments of the Rio Grande do Sul coastal region. This system was also called Lavallega Group since on lithologic grounds (Bossi, 1966) it was considered identical to the second ectinitic system — the true Lavallega Group — and separated from it solely by the mig-



matitic zone of eastern Uruguay. This interpretation cannot be supported henceforth. We propose the name *Rocha Group* for this completely separate unit of the eastern coastal region of Uruguay. No faults have been mapped at the contact between this system and the second gneissic-migmatitic zone, but future research may well change the picture.

Several important relationships are observed in this large area as an examination of Fig. 2 will show.

First, the two gneissic-migmatitic zones are limited by faults. There is an apparent exception in Uruguay, as already pointed out.

Second, granitic intrusions are numerous and preferentially associated with the gneissic-migmatitic zones and the neighborhood of faults. This seems to indicate that these discontinuities were not deep enough to reach the mantle and that they were already active during the late-tectonic magmatism (at about 600 m.y.).

Third, the molassic and acidic volcanic deposits, synchronous to the Brazilian orogenesis, are deposited preferentially on the gneissic-migmatitic zones, showing that the latter were intermontane low regions, with a more rigid behaviour than the lateral ectinitic systems.

Fourth, pre-Brazilian nuclei have been observed in the first gneissic-migmatitic zone, while none are known from the second gneissic-migmatitic area. This may be due to the difficulty of recognition in the field, or because they are not yet exposed at the present-day erosion level.

These observations lead us to consider the gneissic-migmatitic zones as playing the role of *median massifs* (Abdullayev and Borisov, 1965). Thus more mobile areas — corresponding to the three ectinitic systems — alternate with more rigid areas of earlier consolidation, as represented by the gneissic-migmatitic median massifs. From northwest to southeast, we propose to name them *Apiáí Folded System*, *Joinvile Median Massif*, *Tijucas Folded System*, *Pelotas Median Massif* and *Eastern Uruguay Folded System*, corresponding respectively to the first ectinitic system, the first gneissic-migmatitic zone, the second ectinitic system, the second gneissic-migmatitic zone and the third ectinitic system (Fig. 3).

In the preceeding discussion we omitted the São Roque Group. Hennies *et al.* (1967) showed that the Taxaquara Transcurrent Fault is a tectonic contact between the São Roque and the Açungui Groups and estimated a minimum horizontal slip of 150 km; all along the mapped extension, it is not possible to match the two blocks. Hasui (in press) pointed out that characteristics such as synchronism, lithological similarity and resemblance of metamorphic history do not prove equivalence of the two stratigraphic units. Hasui (*op. cit.*) also pointed out their different structural evolutions and suggested that they could have been formed in two different geosynclinal basins, the present geographic distribution being a result of transcurrent displacement.

The São Paulo Transcurrence Zone adds a new dimension to the problem. If the net slip is around 300 km and if one considers the transversal structure of the Ribeira Folded Belt, it seems that the Açungui and São Roque Groups are not parts of one continuous stratigraphic unit. It is probable that the São Roque Group was originally part of another system parallel to the Apiáí System, and situated to the northwest of it.

We can, furthermore, examine the polarity in the Ribeira Belt. It is turned to northwest in southern São Paulo and Paraná States. The geotectonic sketch proposed by Picada (1971) for the Sul-Riograndense Shield indicates a polarity to east-southeast. In the Lavalleya Group, if we consider the metamorphic zoning, the polarity seems to be turned westwards, to the Rio de La Plata Craton. In fact, the epimetamorphic rocks of the Lavalleya Group pass eastwards gradually to a mesometamorphic zone with the Sierra Ballena Formation, and further on to migmatites. However, the structural attitudes indicate



an opposed polarity, as they dip to the west. In the Eastern Uruguay System the structures dip to east, and the polarity is turned to the west. In the São Roque Group, in spite of local variations, there is a predominance of indications of polarity to northwest; the problem of structural polarity is that the visible folds in outcrops are post-schistosity and have sub-vertical axial planes. Studies about superimposed foldings in these regions are only at their beginning.

**CONCLUSIONS** The considerations presented allow us to trace some most important conclusions.

1. There is a longitudinal differentiation and the three segments we have distinguished — including the São Paulo Transcurrence Zone — show clear dissimilarities.
2. The longitudinal differentiation is not yet well understood, but the São Paulo Transcurrence Zone certainly played an important role in its formation.
3. The transversal differentiation of the Southern Segment is done by the Apiaí Folded System, the Joinville Median Massif, the Tijucas Folded System, the Pelotas Median Massif and the Eastern Uruguay Folded System, distributed from NW to SE.
4. All the tectonic units of the coastal region between southern Bahia and Uruguay compose the Ribeira Folded Belt.
5. The São Roque Group occurs in the western part of the São Paulo Transcurrence Zone. Similarities of lithology, ages and metamorphism are not reasons enough to consider that stratigraphic unit as an extension of the Açungui Group.
6. Characteristics of the Ribeira Belt in Uruguay do not indicate the equivalence of the ecinitic rocks of Eastern Uruguay with those of the Lavalleya Group; we consider it a separate unit and propose the name Rocha Group for it.
7. The polarity in the Ribeira Belt is not yet known and the data show disagreement in the Tijucas System.

**Acknowledgements** Authors are grateful to Prof. Dr. Georg R. Sadowski for the critiques and discussions about the ideas exposed, and to Prof. Dr. Horstpeter H. Ulbrich for his revision on the english text.

## REFERENCES

- ABDULLAYEV, K. M., and BORISOV, O. M. — 1965 — Evolution of Central Massifs. *Inst. Geol. Rev.* 7 (8): 1 361-1 367
- ALMEIDA, F. F. M. de AMARAL, G., CORDANI, U. G., and KAWASHITA, K. — 1973 — The Precambrian evolution of the South American cratonic margin south of the Amazon River. *In The Ocean Basin and Margins 1*: 411-446. A. E. M. Nairn and F. G. Stehli (eds.), Plenum Publ. Co.
- AMOS, A. J., QUARTINO, B. J., and ZARDINI, R. A. — 1971 — El Grupo La Tinta (Provincia de Buenos Aires, Argentina): Paleozóico o Précambrico? *An. XXV Congr. Bras. Geol.*, 1: 211-221
- BARBOSA, A. L. M., SAD, J. H. G., TORRES, N., and MELLO, M. T. V. — 1966 — Description of the preliminary geologic map of the middle Rio Doce. *Int. Field Trip to Brazil, guide-book.* Am. Geol. Inst.
- BOSSI, J. — 1966 — Geologia del Uruguay. Universidad de la República, Montevideo
- BRAUN, O. P. G. — 1972 — Faixas rúpteis do Escudo Brasileiro. *Com. ao XXVI Congr. Bras. Geol.*, Belém
- BRITO NEVES, B. B., and ALBUQUERQUE, J. P. T. — 1973 — Geologia e províncias hidrogeológicas de Santa Catarina. *XXVII Congr. Bras. Geol., Resumos das Comunicações*, pp. 87-89

- CARNEIRO, C. D. R., COIMBRA, A. M., and THOMAZ F.º, A. — 1974 — Esboço da diferenciação tectônica do Pré-Cambriano Superior do sul-sudeste do Brasil. Resumos das Comunicações, Bol. Esp. 1: 698-700, XXVIII Congr. Bras. Geol. Porto Alegre
- CORDANI, U. G. — 1973 — Evolução geológica pré-cambriana da faixa costeira entre Salvador e Vitória. L. Doc. Thesis. Inst. Geoc., Univ. São Paulo (unpublished)
- CORDANI, U. G. — 1974 — Comentários sobre as determinações geocronológicas da Folha de Curitiba. Nota Explicativa das Folhas de Curitiba e Asunción, DNPM
- CORDANI, U. G., and BITTENCOURT, I. — 1967 — Determinações de Idades potássio-argônio em rochas do Grupo Açungui. An. XXI Congr. Bras. Geol., pp. 159-165
- CORDANI, U. G., DELHAL, J., and LEDENT, D. — 1973 — Orogenèses superposées dans le Precambrian du Brésil sud-oriental (Etats de Rio de Janeiro et de Minas Gerais). Rev. Bras. Geoc. 3(1): 1-22
- CORDANI, U. G., HALPERN, M., and BERENHOLC, M. — 1974 — Comentários sobre as determinações geocronológicas da Folha de Porto Alegre. Nota Explicativa das Folhas de Porto Alegre e Lagoa Mirim, pp. 70-77. DNPM
- COUTINHO, J. M. V. — 1971 — Estado atual de conhecimento do Pré-Cambriano Superior sul-brasileiro — uma síntese. An. XXV Congr. Bras. Geol. 1: 83-92
- DELHAL, J., LEDENT, D., and CORDANI, U. G. — 1969 — Ages Pb/U, Sr/Rb et Ar/K des formations métamorphiques et granitiques du sud-est du Brésil: états de Rio de Janeiro et de Minas Gerais. Ann. Soc. Géol. Belgique 92: 271-283
- FERRANDO, L. A., and FERNANDES, A. N. — 1971 — Esquema tectônico — cronoestratigráfico del Pré-Devoniano en Uruguay. An. XXV Congr. Bras. Geol. 1: 199-210
- FERREIRA, E. G. — 1972 — Carta tectônica do Brasil — Notícia Explicativa. Bol. 1, DNPM
- FUCK, R. A., MARINI, O. J., TREIN, E., and MURATORI, Y. — 1971 — Geologia do leste paranaense. An. XXV Congr. Bras. Geol. 1: 121-130
- FÚLFARO, V. J. — 1974 — Tectônica da faixa estrutural do Paranapanema. Resumos das Comunicações, Bol. 1: 537-540, XXVIII Congr. Bras. Geol., Porto Alegre
- GIRARDI, V. A. V., CORDANI, U. G., CANDIDO, A., MELFI, A. J., and KAWASHITA, K. — 1974 — Geocronologia do Complexo básico-ultrabásico pré-brasiliano de Piên, PR. Resumos das Comunicações, Bol. 1: 532-533, XXVIII Congr. Bras. Geol., Porto Alegre
- HASUI, Y. (in press) — Evolução polifásica do Pré-Cambriano na região a oeste de São Paulo. Bol. IG., Inst. Geoc., Universidade de São Paulo
- HASUI, Y., and SADOWSKI, G. R. (in press) — Evolução Geológica do Pré-Cambriano na região de São Paulo. Rev. Bras. Geoc.
- HENNIES, W. T., HASUI, Y., and PENALVA, F. — 1967 — O falhamento transcorrente de Taxaquara. An. XXI Congr. Bras. Geol., pp. 159-168
- ISSLER, R. S., DRESCH, R. A. C., and ROISEMBERG, A. — 1973 — Geocronologia do Gabro de Mata Grande, Município de São Sepé, Estado do Rio Grande do Sul. Rev. Bras. Geoc. 3(2): 124-127
- MARINI, O., TREIN, E., and FUCK, R. A. — 1967 — O Grupo Açungui no Estado do Paraná. Bol. Paran. Geoc., n.º 23 a 25: 43-103
- MELCHER, G. C., GOMES, C. B., CORDANI, U. G., BETTENCOURT, J. S., DAMASCENO, E. C., GIRARDI, V. A. V., and MELFI, A. J. — 1973 — Geologia e Petrologia das rochas metamórficas e graníticas associadas do Vale do Ribeira de Iguape. SP. e PR. Rev. Bras. Geoc. 3(2): 97-123
- MINIOLI, B. — 1972 — Aspectos geológicos da região litorânea Piçarras-Barra Velha, SC. Dr. Sc. Thesis. Inst. Geoc., Universidade de São Paulo (unpublished)
- PEDREIRA, A. J., SOUTO, P. G., and AZEVEDO, H. — 1969 — Metassedimentos do Grupo Rio Pardo, Bahia, Brasil. An. XXIII Congr. Bras. Geol., pp. 87-89
- PICADA, R. S. — 1971 — Ensaio sobre a tectônica do Escudo Rio-Grandense. Caracterização dos sistemas de falhas. An. XXV Congr. Bras. Geol. 1: 167-192
- SADOWSKI, G. R. — 1974a — Tectônica da Serra de Cubatão, SP. Dr. Sc. Thesis. Inst. Geoc., Universidade de São Paulo (unpublished)
- SADOWSKI, G. R. — 1974b — Tectônica do Complexo migmatítico da Serra de Cubatão. Resumos das Comunicações, XXVIII Congr. Bras. Geol., Bol. Esp. 1: 557-561, Porto Alegre